Using Satellite Observations to Evaluate the AeroCOM Volcanic Emissions Inventory and the Dispersal of Volcanic SO_2 Clouds in MERRA

Eric J Hughes[1], Nickolay Krotkov[2], Arlindo da Silva[2] and Peter Colarco[2]

(1)University of Maryland College Park, College Park, MD, United States
(2)NASA Goddard Space Flight Center, Greenbelt, MD, United States

Overview

AeroCom Volcanic Emissions Inventory is used as a volcanic input to climate models by describing the:

- Daily SO_2 Emission for a given volcano
- Estimate of the Cloud Top Altitude

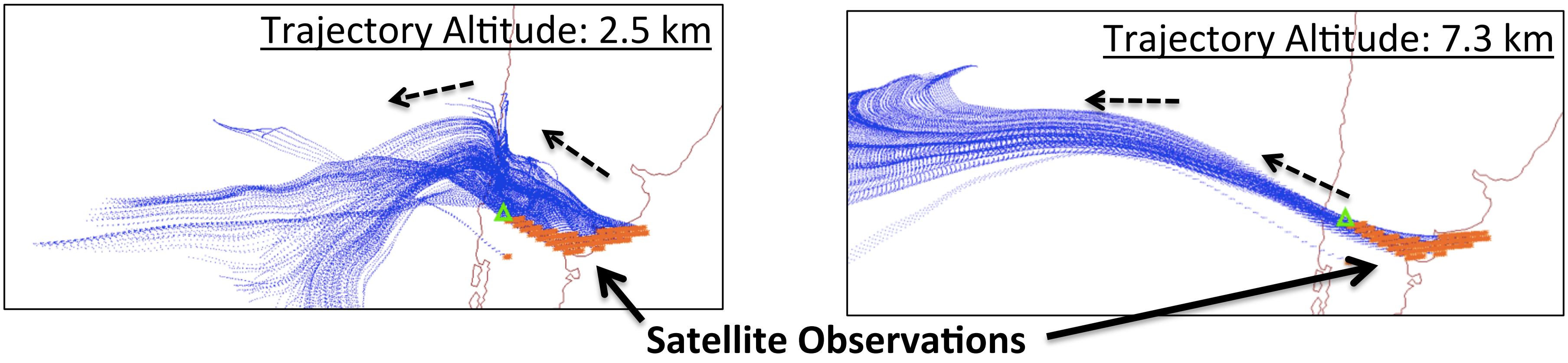
Extends back to 1930s, but most of the detailed information extends to the satellite remote sensing period, back to 1979.

*In select case studies, large differences have been observed between the Modern-Era Retrospective Analysis for Research and Applications (**MERRA)** and SO_2 observations from the Ozone Monitoring Instrument (**OMI**)*

Shown to better understand the nature of these differences:

- Comparison of AeroCom Inventory vs. MERRA input
- Aerocom Cloud Top Estimates vs. Back Trajectory Height Estimates
- MERRA Simulated SO_2 dispersal vs. OMI Observed SO_2 dispersal

<u>Emission altitude and timing can be estimated from *back trajectories from observations*</u>



<u>The Trajectory Transport Test:</u>

A trajectory has successfully described the transport of an SO_2 measurement if it arrives within a minimum distance of the volcano.

The *Distance of Closest Approach*

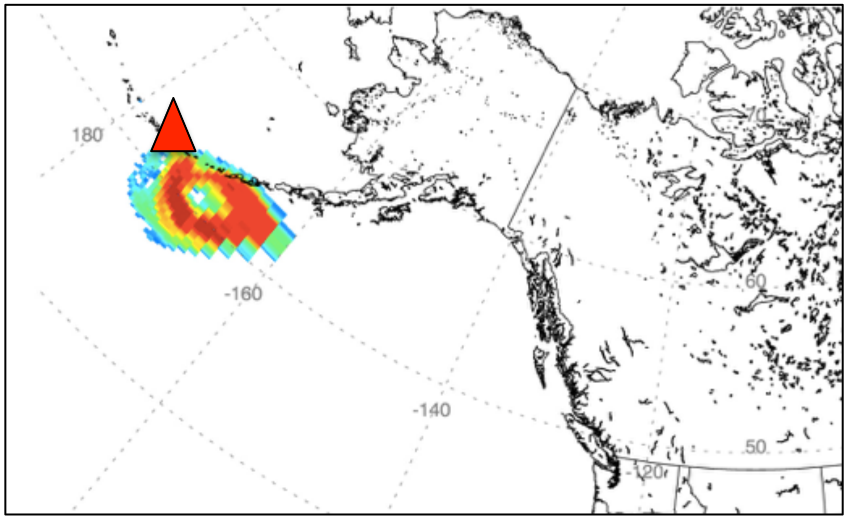
$r^*(\theta,t^*)$

θ- the theta height of that trajectory
t^* - is the time of closest approach

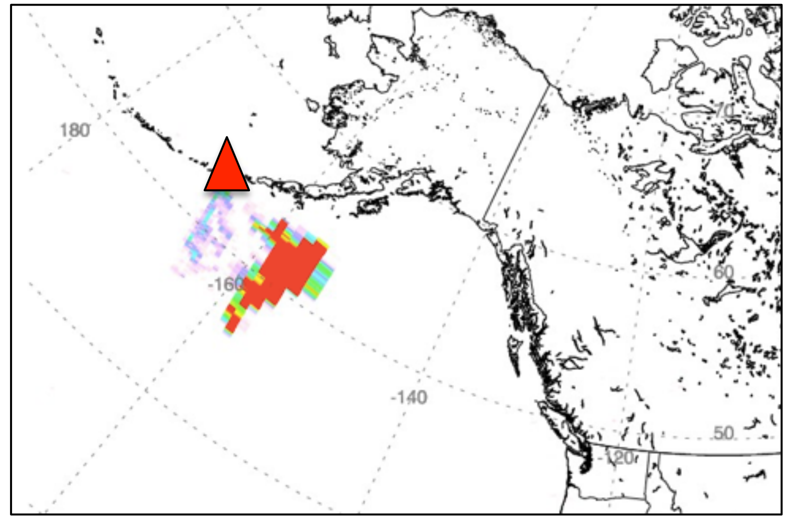
Derive Emission Probability Distribution Functions (PDFs) from those trajectories that arrive within a minimum distance of the volcano

SO_2 Explosive Eruption Case Studies:

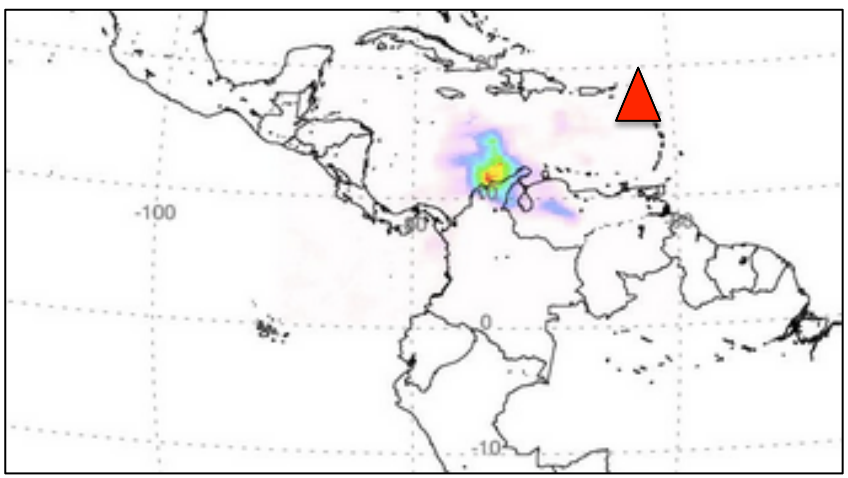
Kasatochi 2008



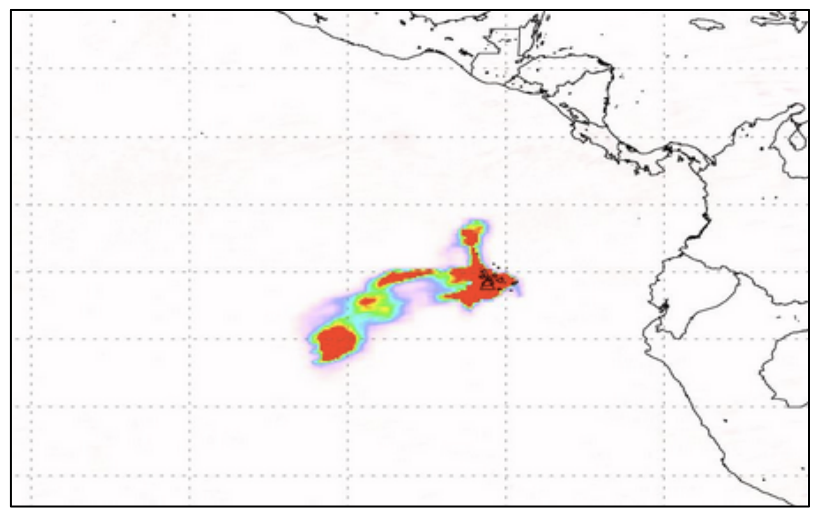
Okmok 2008



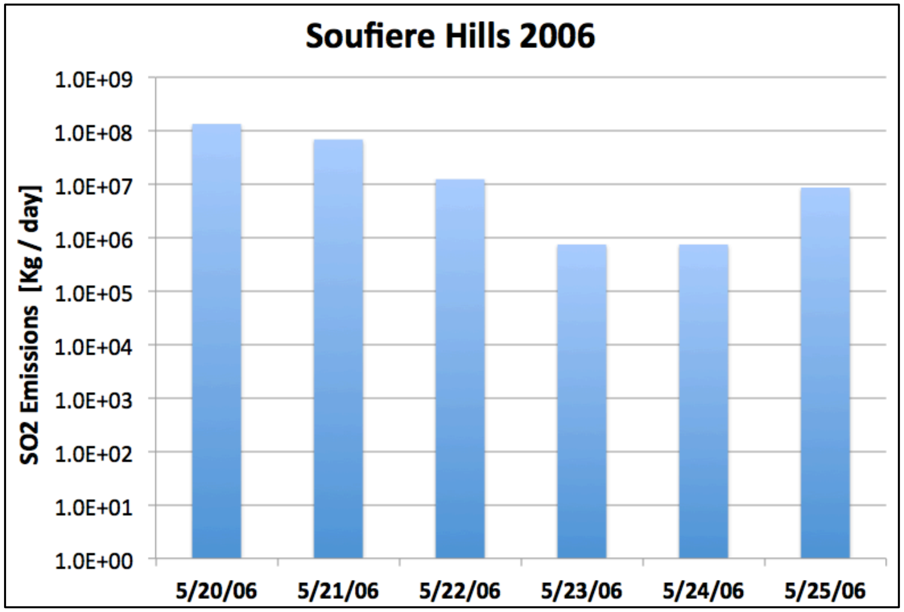
Soufriere Hills 2006

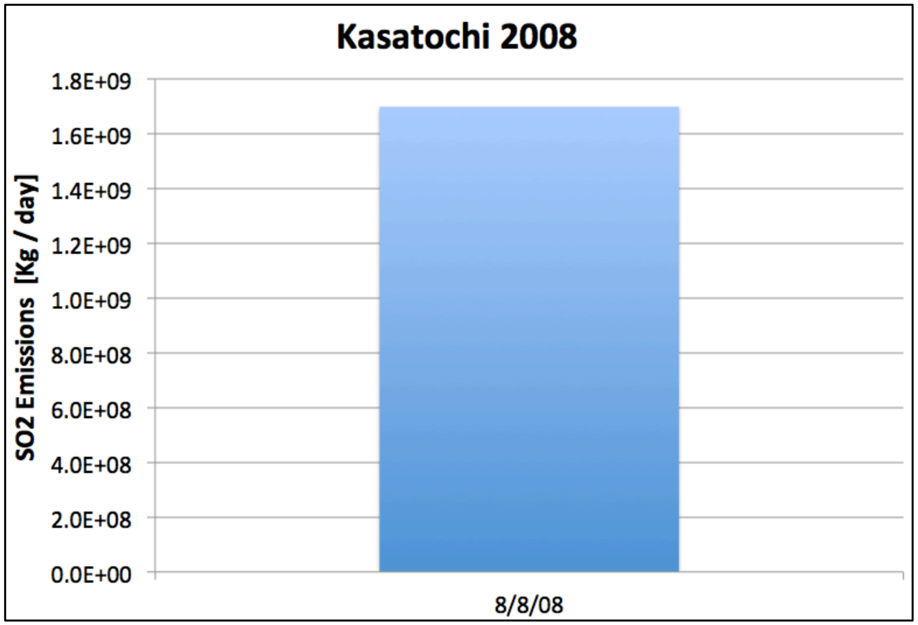


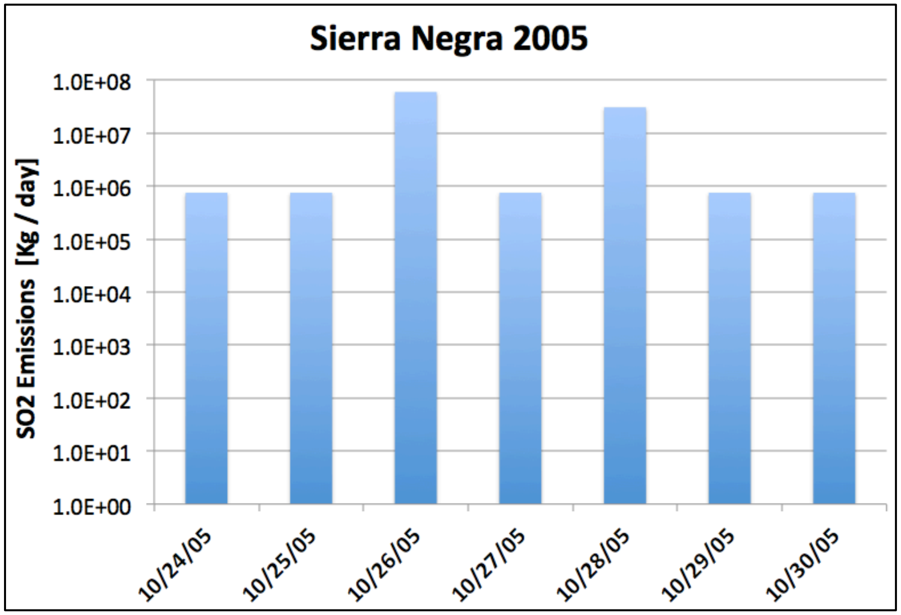
Sierra Negra 2005

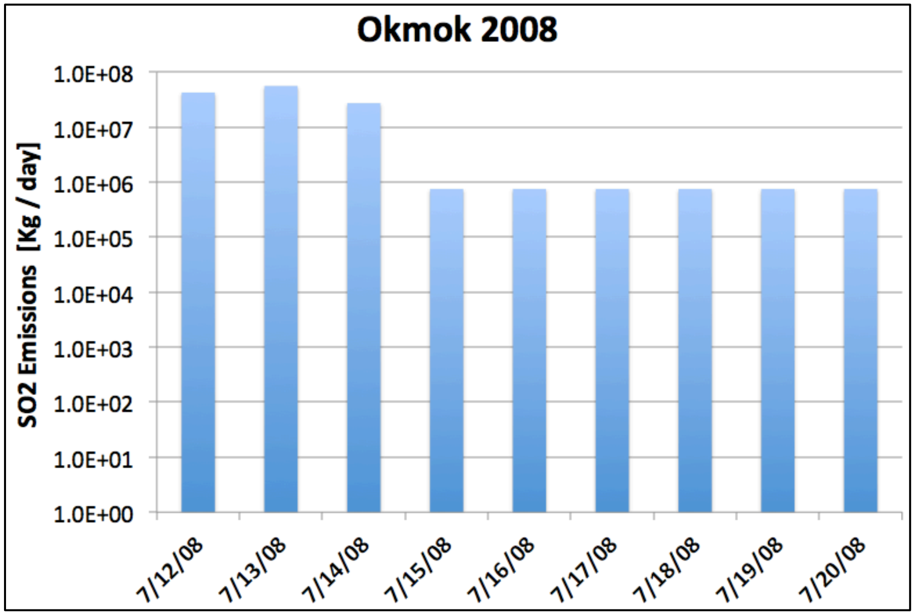


AeroCom Volcanic Emission Inventory: *Select Cases*



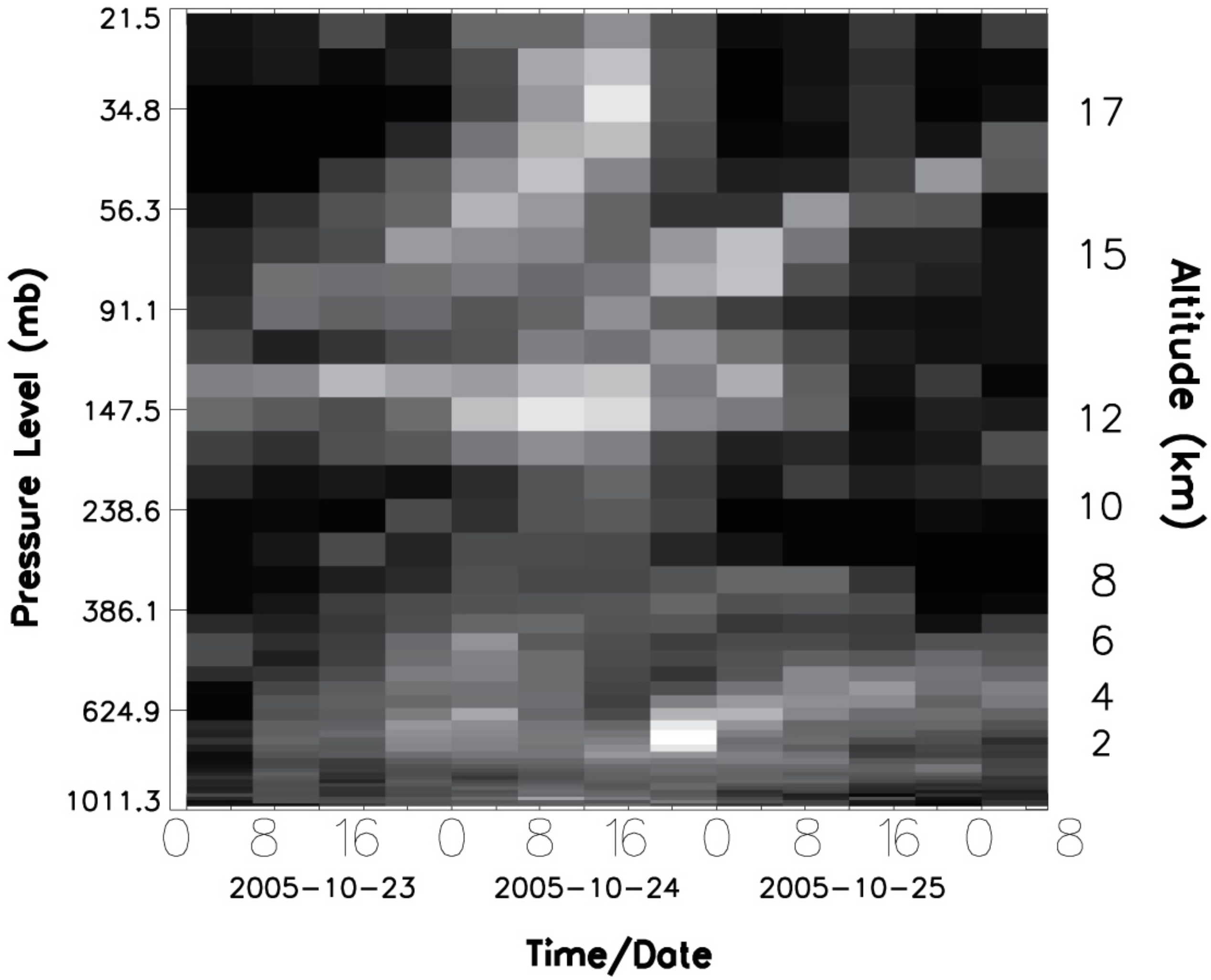






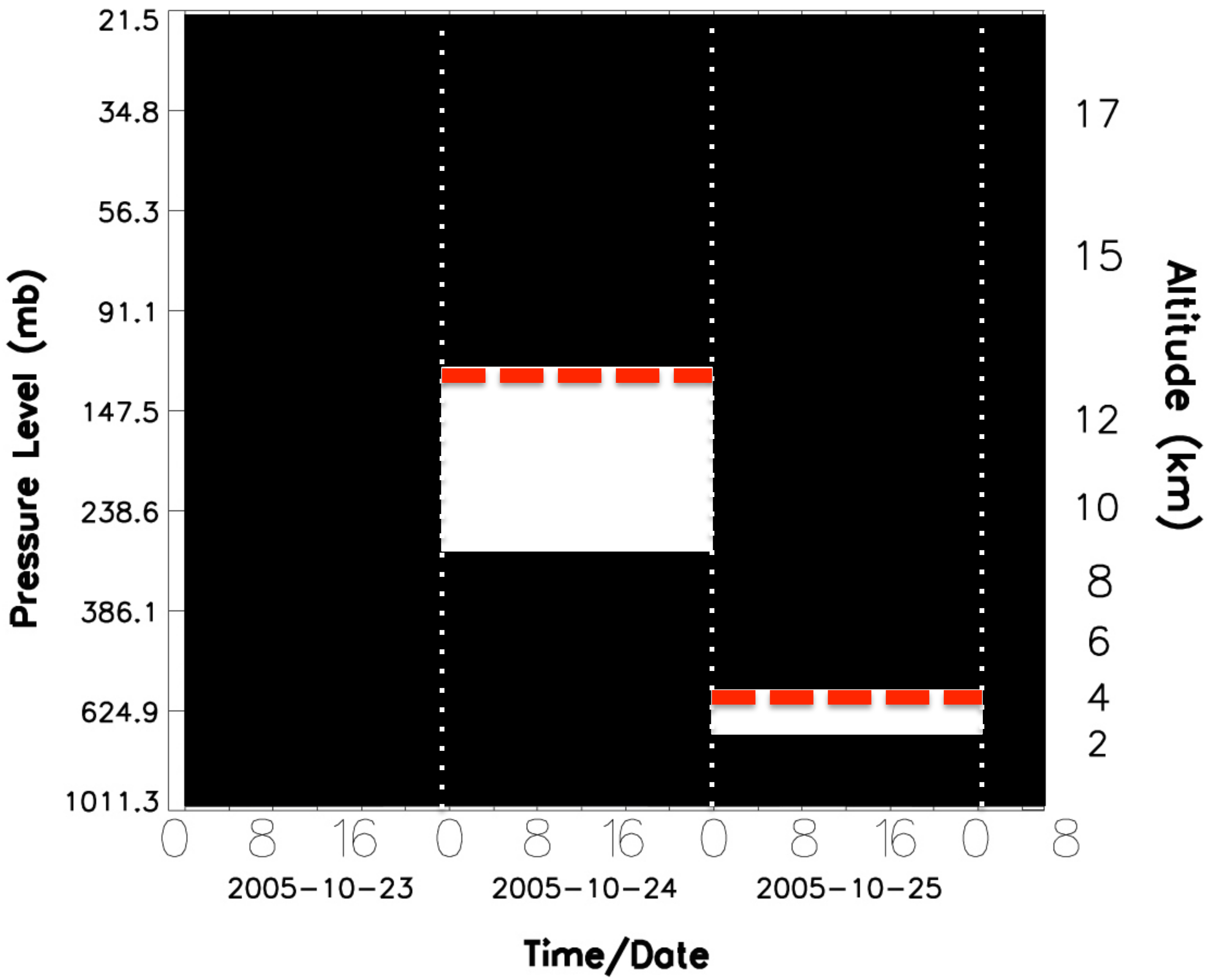
How well do the derived height profiles compare to those assumed in the GEOS-5/GOCART MERRA Run?

SO_2 Emission Height-Time PDF

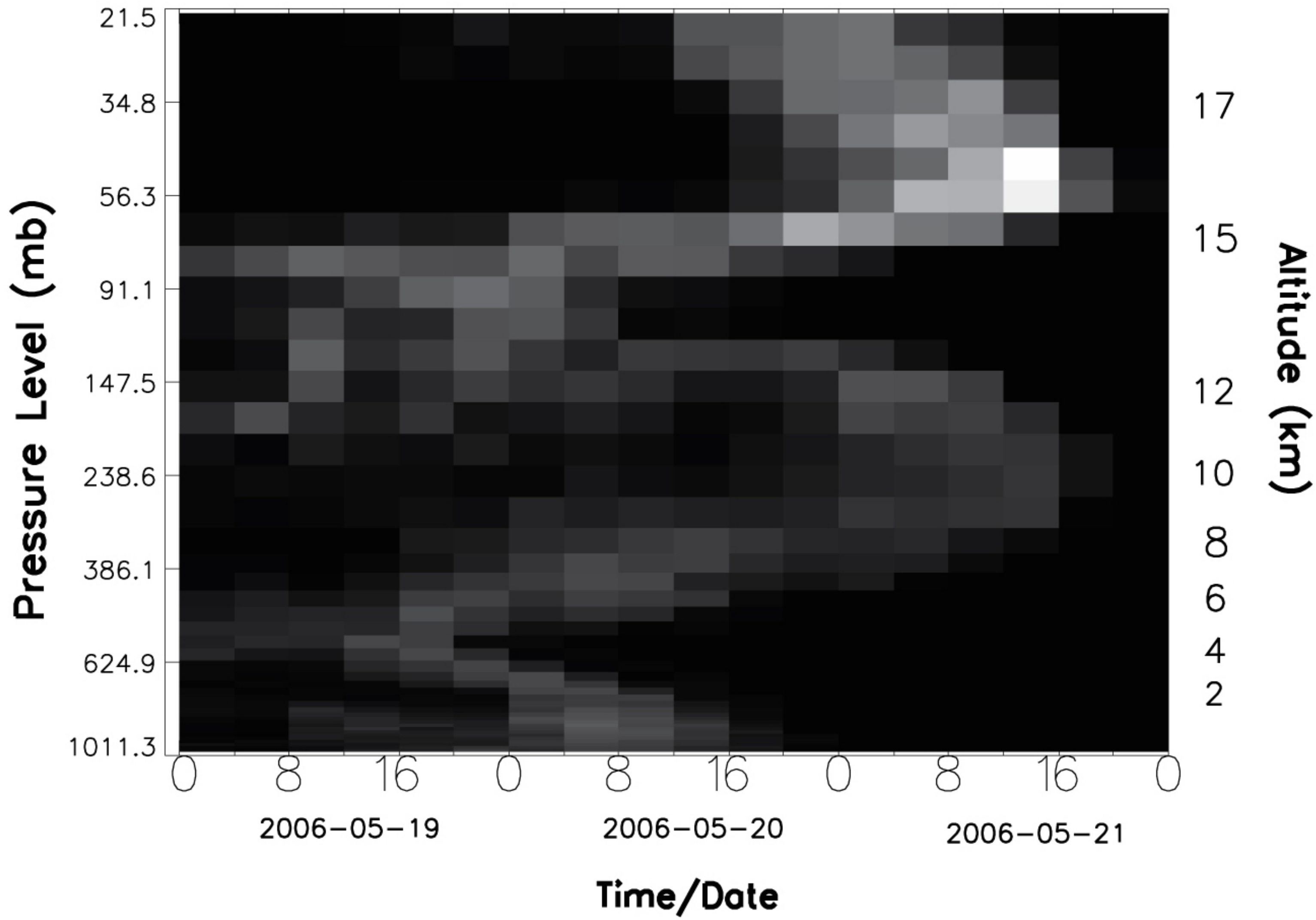


Sierra Negra

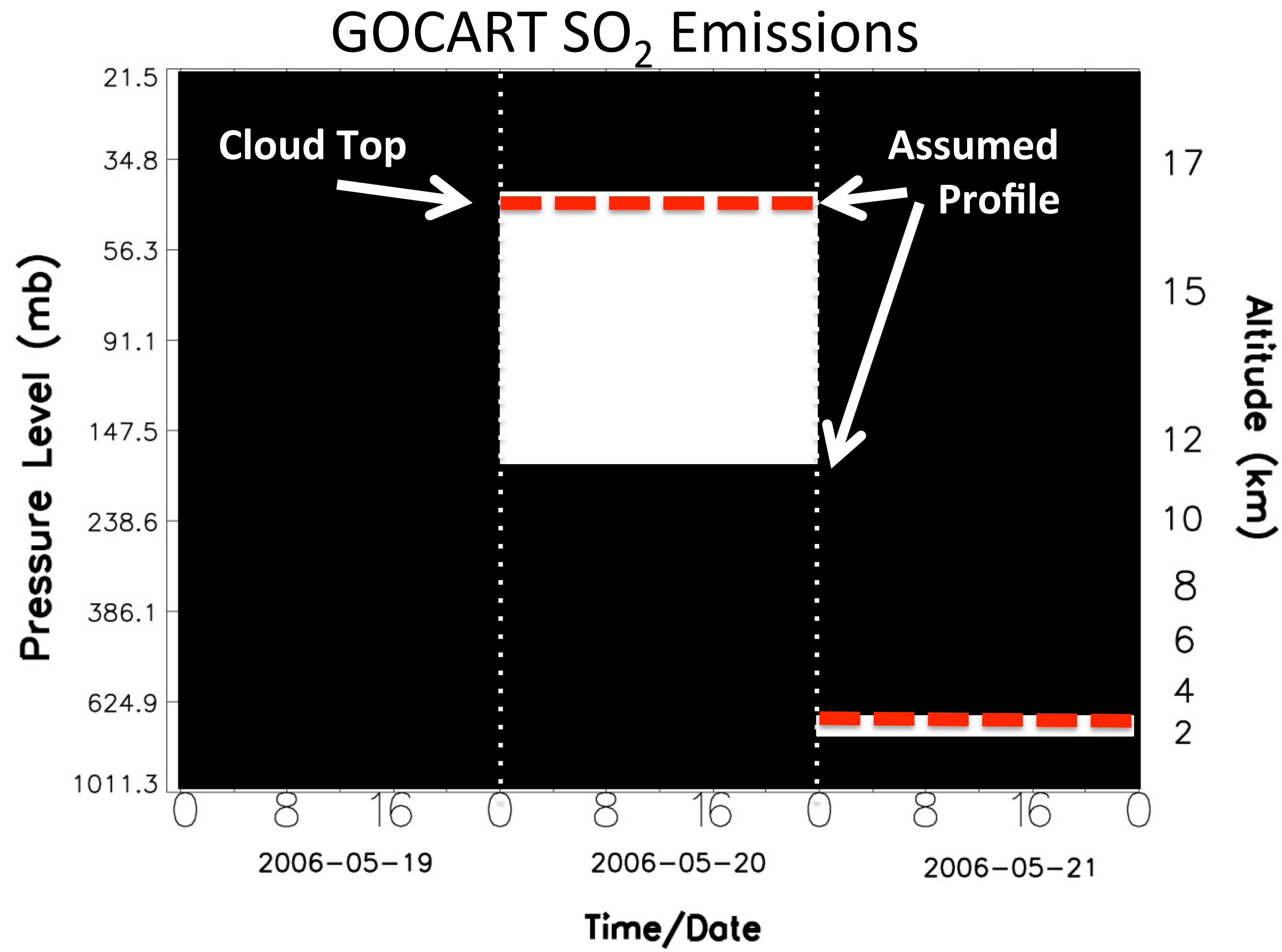
GOCART SO_2 Emissions



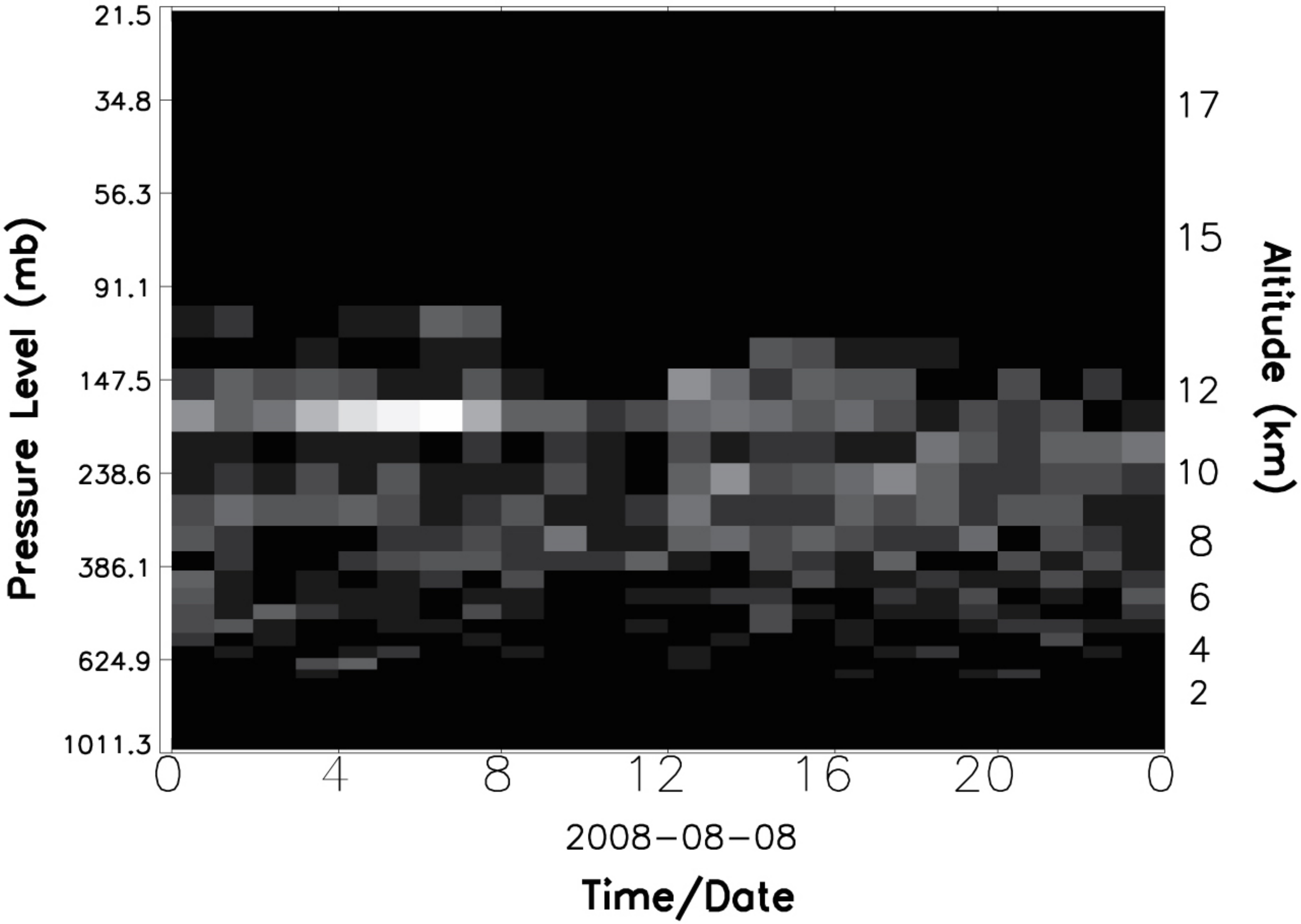
SO_2 Emission Height-Time PDF



Soufriere Hills

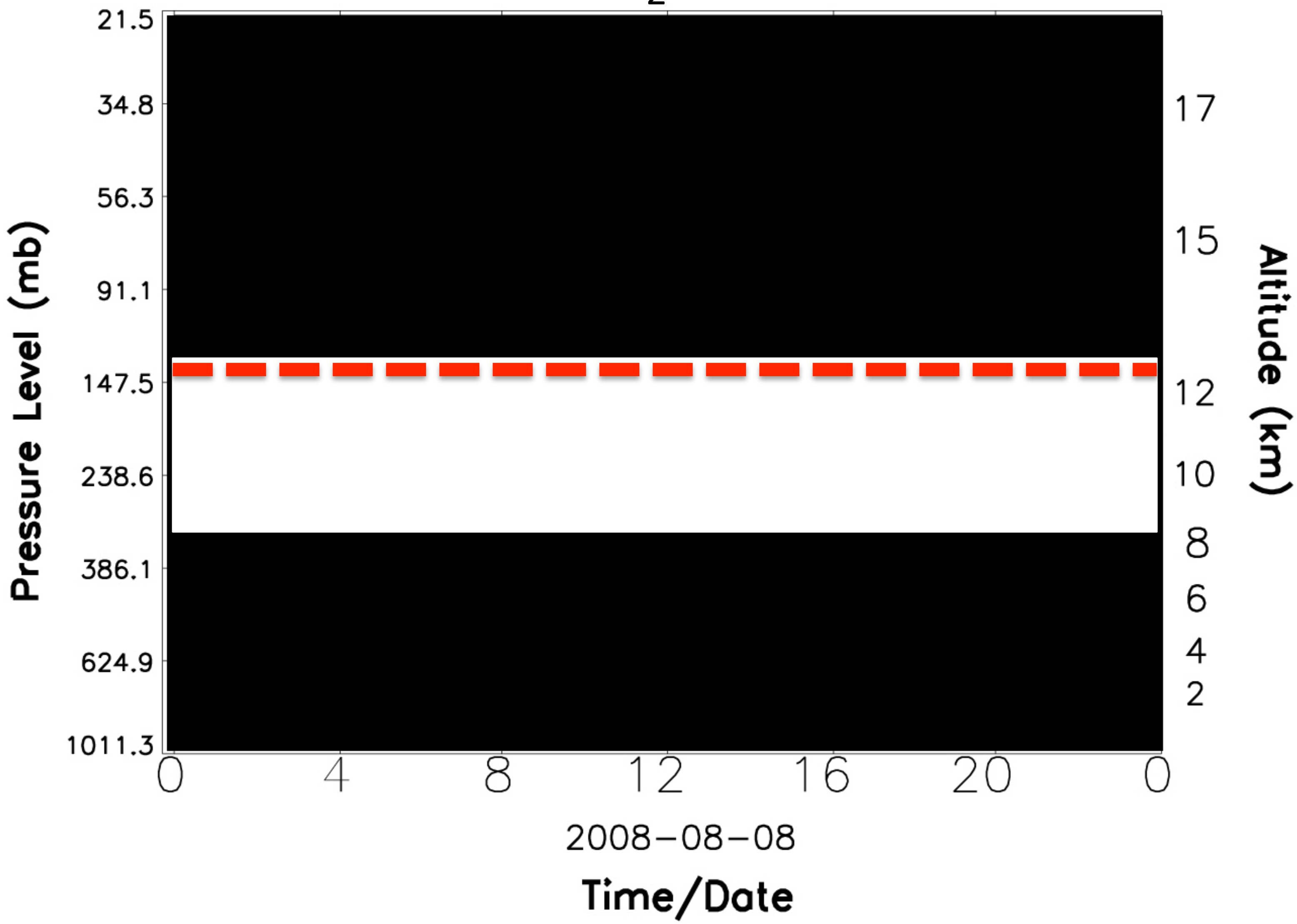


SO_2 Emission Height-Time PDF

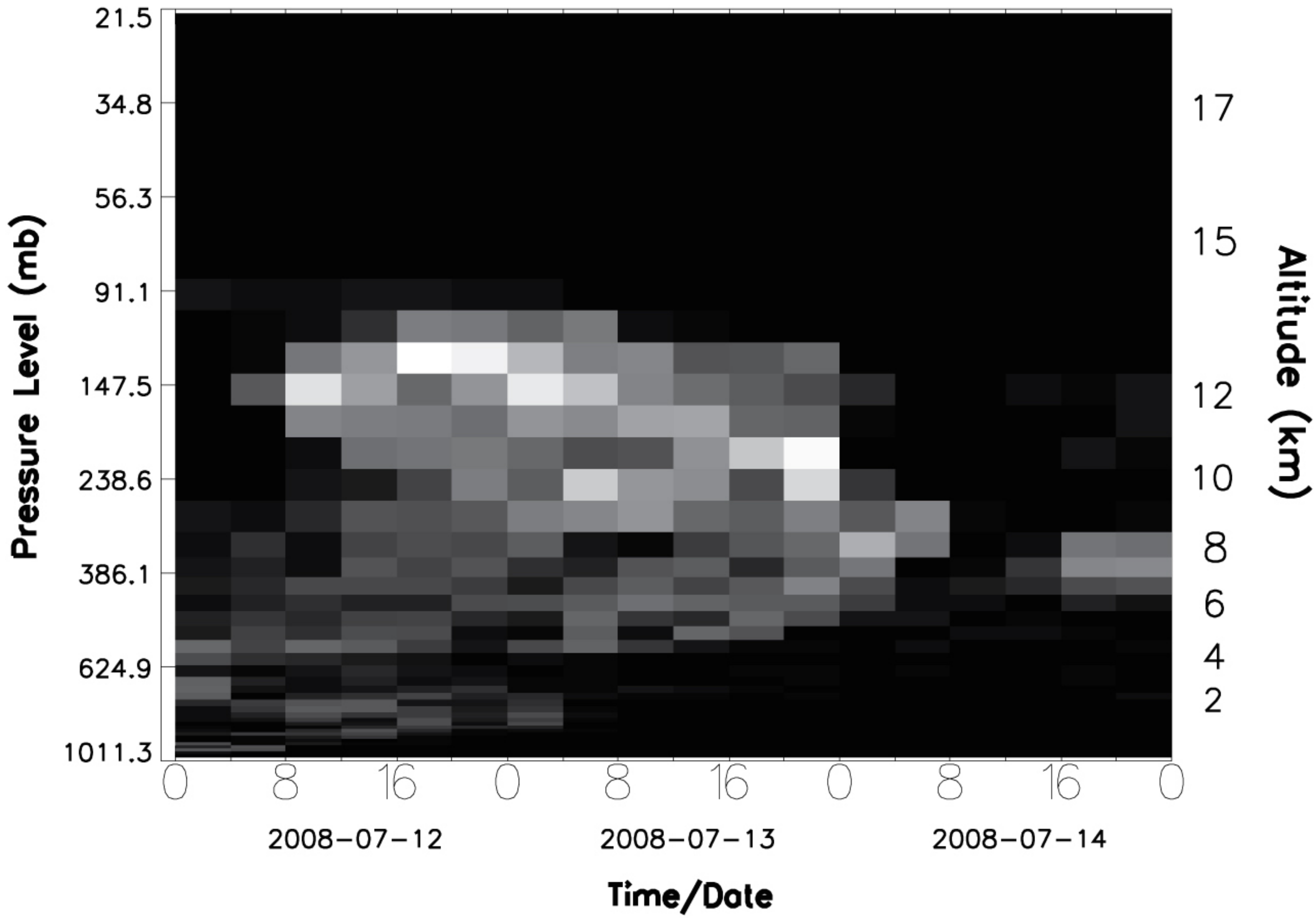


Kasatochi

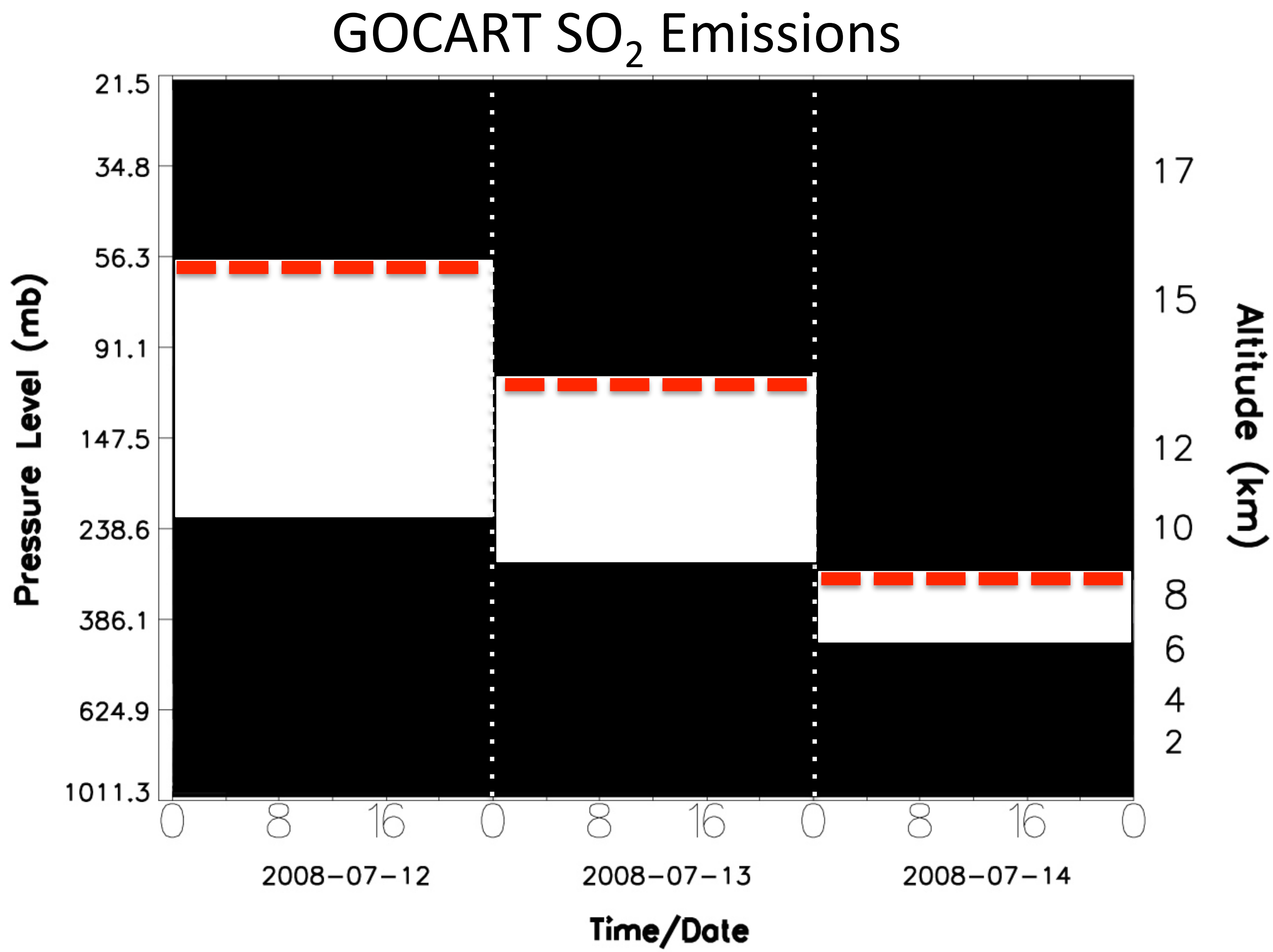
GOCART SO_2 Emissions



SO_2 Emission Height-Time PDF

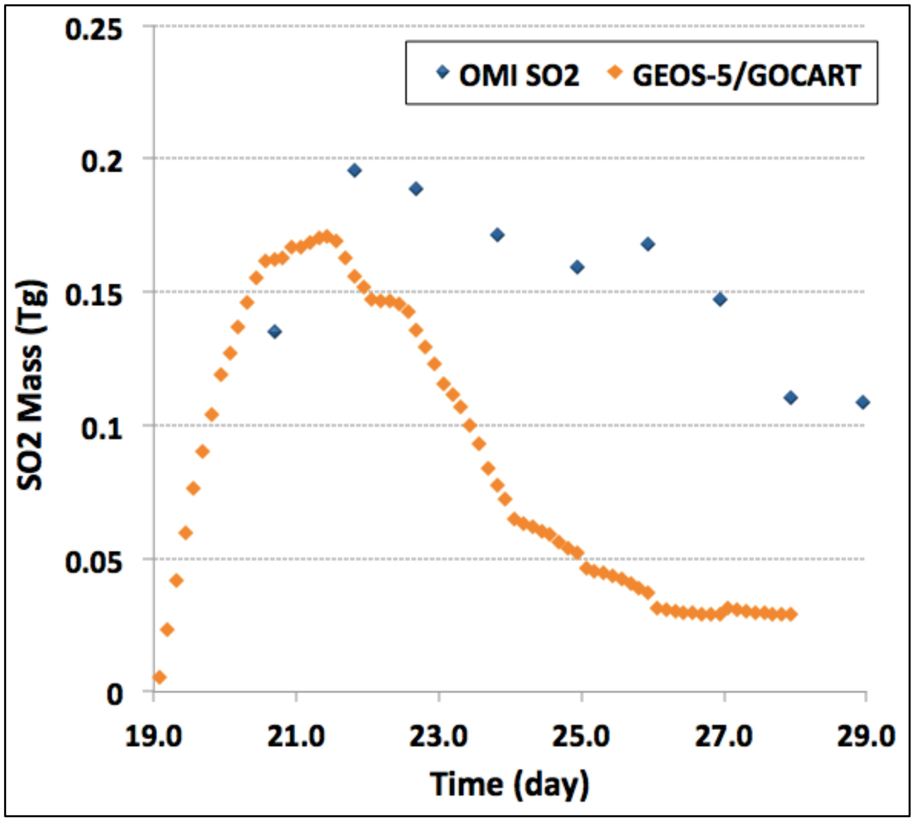


Okmok

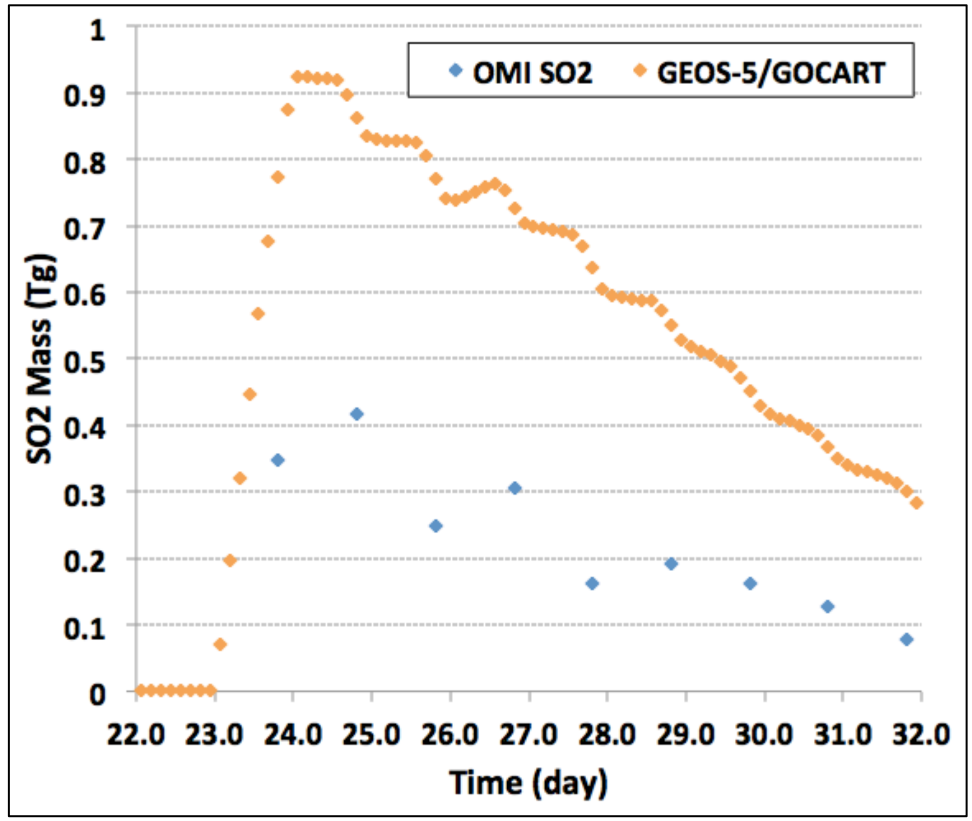

GOCART SO2 Emissions
21.5
34.8
56.3
91.1
147.5
238.6
386.1
624.9
1011.3
Pressure Level (mb)
17
15
12
10
8
6
4
2
Altitude (km)
0
8
16
0
8
16
0
8
16
0
2008−07−12
2008−07−13
2008−07−14
Time/Date

How do satellite observations compare to the simulated SO_2 dispersal?

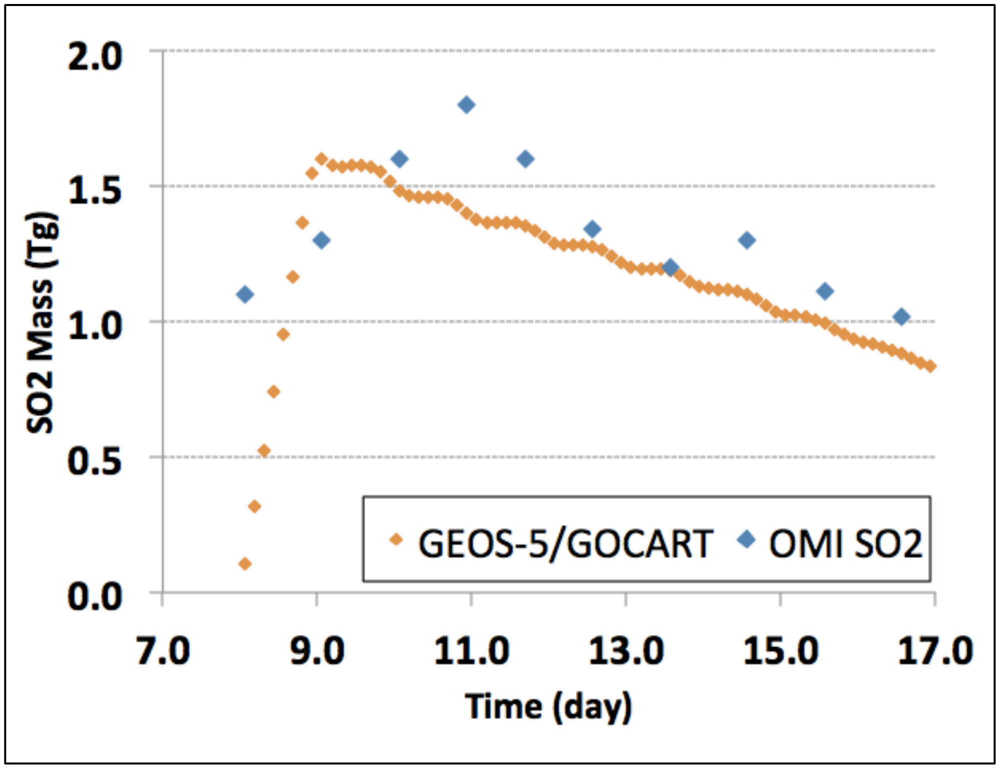
Soufriere Hills



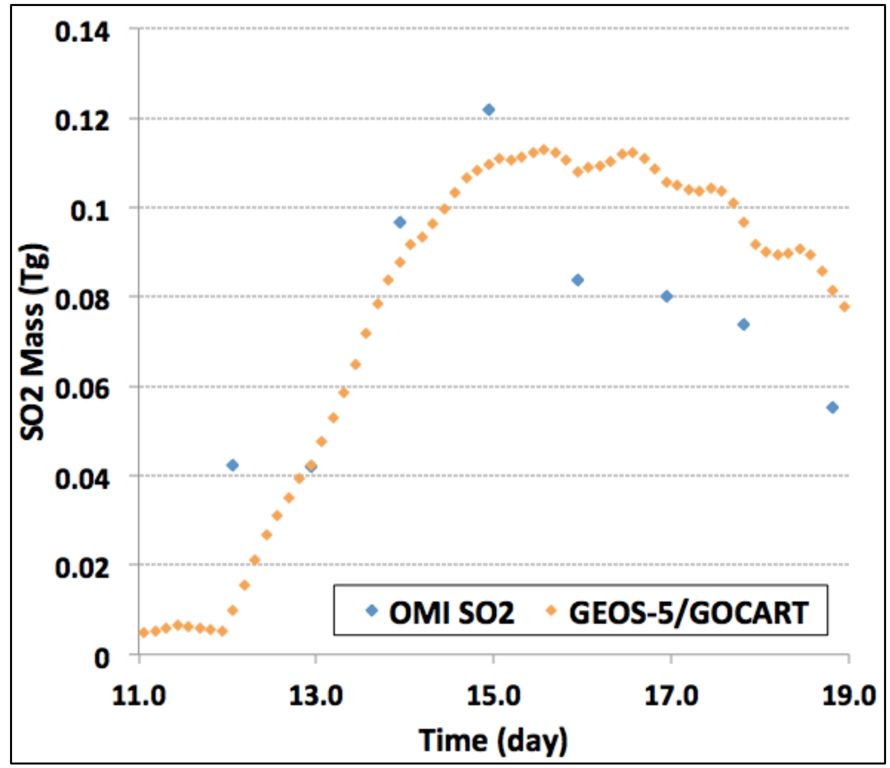
Sierra Negra



Kasatochi



Okmok



Model vs. Satellite: *There is a large disagreement seen in Sierra Negra and Soufriere Hills and better agreement with Kasatochi and Okmok.*

Concluding Remarks

- The assumed profile of 1/3 the column between cloud top and volcano summit
  - Appears incorrect for several eruptions
  - May be pushing SO2 into the lower trop creating incorrect dispersal/loss rates in MERRA (Soufriere Hills)
- Comparing dispersal rates of MERRA vs. OMI can be misleading as continuous emission can give the appearance of longer dispersal rates (Sierra Negra)
- Need to more directly compare OMI and MERRA.